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The Effects of Migration and Household Wealth on Child Health Outcomes in the Context of Rapid Urbanization: The Case of Phnom Penh, Cambodia

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Abstract

How migration status impacts on health disparities among children within the context of rapid urbanization is not well understood. The issue is studied here in Cambodia, which has undergone rapid urbanization over the last decade, with high rates of migration to its capital, Phnom Penh. While child health indicators have seen overall improvement during this period, inequalities may still exist, especially in vaccination coverage and child growth and development. Using data from Cambodian Socio-Economic Surveys, this study examines how migrant status and household wealth associate with key child health indicators, and analyzes whether these associations have changed from 2004 to 2009 in concert with rapid urbanization. Specifically, we examine BCG and DPT vaccination completion among children under two and underweight status among children under five. Using generalized linear latent and mixed models, we account for household and village clustering effects. Household wealth is significantly associated with vaccination and underweight status; children in households in the lowest wealth quintile are significantly more likely to experience poor health outcomes. Migrant status is not associated with vaccination receipt or underweight, although substantially sized coefficients and small sample size suggest Type II errors. Interactions between wealth and migration status are also non-significant. We conclude that children in the poorest households in urban Cambodia face barriers to completing basic vaccinations, and are significantly more likely to be malnourished in early childhood, but further research is needed to understand whether and how migration impacts child health outcomes in urban Cambodia.

Introduction

Significant demographic change in Cambodia has taken place over the last several decades, much of which is a direct consequence of its civil war in the late 1970s and early 1980s (Heuveline and Poch 2007; National Institute of Statistics and Ministry of Planning 2010). Combined with increasing socioeconomic development, the current Cambodian environment encourages internal migration and urbanization. Specifically, fertility rates increased in the post-war era in the 1980s, creating a Cambodian baby boom, while mortality rates declined. The result is a population today that is concentrated in young adult ages. Economic opportunities in Phnom Penh urge many of these young adults to move from rural to urban areas (Fitzgerald et al 2007; Kimsun 2012; Ministry of Planning 2012), with the effect of a swelling of the capital city. The population of Phnom Penh more than doubled as a result of migration between the 1998 and 2008 census periods (Ministry of Planning 2012). Internal migration and urbanization are now by far the most striking demographic phenomena occurring in Cambodia today.

Figures 1 and 2 show the impact of high fertility and low mortality post 1980 on the age structure of Cambodia, and these impacts plus migration on the city of Phnom Penh. Nationally, a high percentage of the Cambodian population is young adults, demonstrating high population growth since the end of the Khmer Rouge regime. The Phnom Penh population pyramid is even more dramatic. It reflects concentrated in-migration of young adults, with a very high proportion of its population ages 15 to 29. Women ages 15 to 24 are especially likely to migrate to Phnom Penh (Ministry of Planning 2012). Therefore, the population of Phnom Penh is in prime childbearing years, and many of these adults are migrants. This will result in high birth rates for the city of Phnom Penh, even given declining rates of fertility.

Cambodia's rapid urbanization provides an opportunity to understand some of the health implications of migration within an environment of socioeconomic development. The age at which the majority of migration takes place, adolescence and young adulthood, means that many young children are moving to Phnom Penh with their parents or are born shortly after a move (Ministry of Planning 2012; Sovannara 2008; Soeung et al 2012). How child health outcomes react to this migration is not well understood. We examine whether children of migrants are disadvantaged with respect to several health outcomes, including vaccination and underweight status. Vaccination is a key marker of child health care access as it requires regular contact with the health system over a child's first year of life. Basic vaccines confer immunity against common infectious disease, and result in reduced mortality in childhood (Breiman et al 2004). Nutrition status is a measure of a child's growth and development; malnourishment is an important underlying cause in many child deaths in developing countries, especially those associated with infectious disease and multiple concurrent illnesses (Black et al 2003). Malnutrition is measured by stunting, low height-for-age, wasting, low weight-for-height, and underweight, low weight-for-age. Underweight reflects acute and chronic undernutrition (WHO 1995).

Background

A reduction in mortality in Cambodia over the last couple of decades is in part a function of the decline of infant mortality. From 2000 to 2010, infant mortality has been more than halved, decreasing from 95 to 45 deaths per 1,000 live births (National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011). Along with this reduction in infant mortality has come improvement in child health indicators, especially in urban areas. For example, in Phnom Penh, Cambodia Demographic and Health Survey (DHS) data indicates completion of the basic immunization package among one year olds increased from 61.8% in 2000 to 84.2% in 2010 (National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011; National Institute of Statistics, Directorate General for Health, and ORC Macro, 2001). The percent of children in Phnom Penh who are underweight decreased from 35.0% in 2000 to 18.5% in 2010, and the prevalence of wasting in Phnom Penh decreased from 18.3% in 2000 to 11.2% in 2010. However, not all indicators have improved; the prevalence of stunting among children in Phnom Penh has remained nearly stagnant, with 25.6% stunted in 2000 and 25.0% stunted in 2010.

Given relatively broad variation in child health outcomes in Cambodia generally and Phnom Penh specifically, understanding the determinants of these outcomes becomes important for the delivery of public health programs. Determinants of child health include individual, parent and household, and community level factors. Individual level factors include the child's sex, child's age, and whether he or she was born in a health facility (Ikeda et al 2013; Chhabra et al 2007; Babalola 2009). Household factors often relate to nutrition and vaccination; maternal education has proven to be among the strongest correlates of infant and child mortality, children's nutrition status, and immunization (Hobcraft 1993; Desai and Alva 1998; Parashar 2005; Chhabra et al 2007). Other predictors include maternal age, household wealth status, paternal education, maternal working status, and household size (Zeitlyn et al 1992; Lamontagne et al 1998; Sohn et al 2001; Ricci and Becker 1996; Chamratrithirong et al 1987).

The current study focuses on determinants of child health outcomes in an urban center. Research from a variety of countries indicates that children's health status is generally better in urban areas than rural (Van de Poel et al 2007). For example, a meta-analysis of children's height-for-age and weight-for-height Z-scores in 141 low- and middle-income countries from 1985 to 2011 found that urban children are significantly more likely to be taller and heavier than their rural counterparts; the urban-rural differential increased over time in Southeast Asia (Paciorek et al 2013). In Cambodia, the 2010 Demographic and Health Survey showed that 42.2% of rural children were stunted compared to 27.5% of urban children (National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011). However, 11.6% of urban children were wasted in comparison to 10.8% of rural children. 85.5% of urban children received all basic vaccinations compared to 77.4% of rural children. Though care seeking rates were similar between urban and rural children, 48.8% of urban children received antibiotics when they experienced an acute respiratory infection, compared to 38.2% of rural children, indicating the improved stocking of essential medicines and higher quality of health services in urban areas.

One reason for an urban advantage is that families in urban areas tend to live in closer proximity to a health center compared to those in rural areas. Moreover, in Cambodia, maternal education is generally higher, uptake of antenatal care is greater, and delivery with a skilled attendant is more frequent in urban areas (National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011). As these are important predictors of infant and child health and mortality (Ikeda et al 2013; Oyekale 2012), urban children may have an advantage from the beginning of life.

Yet, the benefits of urban living for child health are not likely to be equitable. Evidence from other countries suggests that the children of the urban poor are more likely than rural children to experience lower vaccination rates (Gong et al 2012), and higher rates of malnutrition, stunting and wasting (Pryer et al 2002), respiratory infections (D'Souza 2003), and diarrhea (Graf et al 2008). The urban poor are at high risk for stunting and mortality in comparison to rural children

(Van de Poel et al. 2007). These risks are compounded by other health-related consequences of living in over-populated areas with poor sanitation.

Migration can impact upon child health determinants in many ways (Hildebrandt et al. 2005). Children of migrant parents may miss out on key services such as vaccination if their parents are unfamiliar with available services. Recent migrants to Phnom Penh may be especially disadvantaged if they arrive with few resources and earn low incomes (Ministry of Planning 2012). In one study of poor communities in Phnom Penh, including migrants, the urban poor reported that they at times avoided seeking health care services due to cost, even though they may have been exempt from payment under a government anti-poverty program (Soeung et al 2012). Children may face additional challenges when migrant parents settle into transitional neighborhoods with high concentrations of migrants.

The current study examines several key individual, household, and community level determinants of child health outcomes, while accounting for between community heterogeneity. The inclusion of the community in which a child resides allows us to adjust for between community heterogeneity in child health outcomes. Poor health outcomes may be concentrated in areas of the city with higher proportions of urban poor or recent migrants. These populations often experience poorer health outcomes, suggesting that clustering effects may drive the spatial distribution of child health outcomes, with children in poorer neighborhoods more likely to suffer negative health. There are key contextual and community-level factors that influence child health outcomes, including distance to a health care facility, neighborhood infrastructure, and neighborhood poverty (Babalola 2008; Kiros and White 2004; Parashar 2005), among others, suggesting the possibility of a neighborhood effect among the urban poor. Wisongye et al (2010) found clustering of immunization rates in a meta-analysis of 24 Sub-Saharan African countries. In a multilevel analysis of under-5 mortality in the context of rapid urbanization in Nigeria, Antai and Moradi (2010) found significant clustering effects in poor neighborhoods, with children in these areas at increased risk of death compared to those in more advantaged neighborhoods.

By better understanding health disparities among urban children and specific factors that increase their vulnerability to poor health outcomes, policy-makers and key stakeholders can better target programs and interventions to increase access to care. With the availability of detailed multilevel data from the Cambodian Socio-Economic Survey, this paper focuses on how migration status couples with household wealth and poverty to impact upon key child health indicators in the rapidly growing city of Phnom Penh, Cambodia. It also seeks to determine whether this association changed over time from 2004 to 2009, a period during which there was enormous movement of families from rural to urban areas.

Methods

Data

This study uses data from the 2004 and 2009 waves of the Cambodian Socio-Economic Survey (CSES). The CSES is a repeated cross-sectional nationally representative household survey. Prior to 2007 it was conducted every few years and since that time has been annual. It is organized and implemented by the National Institute of Statistics (NIS) of Cambodia with support from the Swedish International Development Cooperation Agency (Sida). The main purpose of the survey is to obtain estimates on the social and economic wellbeing of the Cambodian population and as such includes information on housing, income, consumption, durable goods, labor force, educational attainment, and other such characteristics of interest to the estimation of population wellbeing. Information is provided through a diary and interviews with household informants. A household roster includes demographic information on all household members. In addition, the CSES incorporates modules that change on a yearly basis. Every fifth year there is a child health module; the current study uses data from this module. While the CSES has been under-used as a data source for scholarly inquiry, several notable publications using CSES data can be referred to for additional information on the survey (De Walque 2006; VanLeit et al 2007; Xu et al 2003; Zimmer and Kim 2001).

The CSES uses multistage random sampling techniques with primary sampling units at the village level (the smallest administrative level throughout the country); and households chosen within villages. This study is limited to households in the city of Phnom Penh. The total number of households in the 2004 and 2009 CSES was 15,000 and 12,000 respectively for the entire country and 1,400 and 1,113 in Phnom Penh. The 2004 survey included 83 villages in Phnom Penh, and the 2009 survey included 101 villages in Phnom Penh. For this analysis, children, either under age two or under age five depending on the outcome measure, are units of analysis. Within these Phnom Penh households are 434 children under five in 344 households and 170 children under two in 160 households in 2004. In 2009, there were 429 children under five in 348 households and 185 children under age two in 181 households.

Measures

Dependent variables: Our analysis involves examining a series of child health outcomes that are consistently measured across the 2004 and 2009 CSES. These include vaccination status for Bacillus Calmette-Guérin (BCG) vaccine and diphtheria-pertussis-tetanus (DPT) combined vaccine, and underweight status among children less than five years of age. Cambodia followed the World Health Organization (WHO)-recommended vaccine schedule at the time of these surveys. In 2004, children with a complete schedule received a one-dose BCG vaccine against tuberculosis at birth, three doses of DPT-combined vaccine and oral polio vaccine at 6, 10, and 14 weeks, and a one-dose measles vaccine at 9 months. In 2009, children also received a Hepatitis B vaccine at birth, and a combined DPT-Hepatitis B vaccine was introduced in 2005.

BCG vaccination status is measured among children two to 23 months and coded as a dichotomous variable indicating whether or not the child received the vaccine. DPT vaccination is measured among children six to 23 months as a dichotomous variable; a child is considered vaccinated if he or she completed the three dose series. The CSES verifies immunization via presentation of the child's Ministry of Health-issued vaccine card, and does not rely on mother's recall if the vaccine card is not presented. 92.9% of children who had ever been vaccinated in survey years 2004 and 2009 presented a vaccine card. Therefore, measurement of vaccination status is quite valid.

Low weight-for-age, or being underweight, is included as an indicator of malnourishment and was recorded for children under five using anthropometric z-scores. Underweight is measured as a dichotomous variable, using weight-for-age z-scores in accordance with the World Health Organization's (WHO) Child Growth Standards (World Health Organization 2006). The weight-for-age z-score expresses a child's height in terms of standard deviational units above or below the median weight for healthy children in a reference group. A child is considered underweight if he or she is two or more standard deviations below the reference median weight for his or her age in months.

Independent variables: The main independent variables of interest in this analysis are: 1) household wealth; 2) migration status, and; 3) year of survey. A household wealth measure is constructed using detailed household diary data on income, expenditures, and durable goods. Participants log all household expenses, ranging from food to rent to education fees, as well as all income to the household, such as formal employment wages, self-employment income, and remittances, over a one month period. These items are combined to create a daily household per capita aggregate income measure. The measure is comparable across survey years by being held constant in 2009 Cambodian Riels. The aggregate income measure is divided into wealth quintiles for each survey year. The CSES allows a measure of wealth quintile for the total country, but as urban households have greater wealth and employment income than rural households, a normal distribution of wealth within the city is not well reflected by national wealth quintiles. Therefore, the current study uses a quintile categorization based on Phnom Penh households only, including all Phnom Penh households in a survey year, not only those with a child under five. In regression analyses, household wealth quintile is considered as a continuous variable with a score of 1 indicating the lowest wealth quintile and a score of 5 indicating the highest.

The survey asked whether respondents had moved to their current village of residence from elsewhere, and if so, the number of years they have lived in their current village. A migrant is defined as a person who moved from a village of origin outside Phnom Penh within the preceding five years. A child is considered a migrant if they have at least one parent who is a migrant. Year is dichotomized into 2004 and 2009.

To adjust for factors that may mediate the association between migration, wealth, year and child health outcomes, we introduce a series of control variables that are available in the dataset. These include child's age, child's sex, mother's education, father's education, household size, mother's age, mother's current work status, and treating household drinking water. Child's age is measured continuously in years, and is included only analysis of underweight status. Child's sex is dichotomized, with male as the reference category. Mothers and fathers are dichotomized as having incomplete or complete primary education versus any secondary education or higher. Mother's age is measured continuously in years. Mothers are defined as working if they reported paid labor outside the home in the previous seven days. Household size is measured as the total number of residents in the child's household unit, and is included in the analysis examining whether children are underweight. Whether a household treats drinking water is included only in the analysis of underweight. If the primary household respondent reported that the household always boiled or otherwise treated drinking water the previous month, versus sometimes or never, the household is categorized as treating its drinking water.

We also account for a few variables that are available at the administrative village level within which an individual lives. Factors adjusted for at the village level include distance to a health center and percent of households within the village with access to piped water. Distance to a health center is rounded to the nearest half kilometer and included as a continuous variable. The percent of households within a village with access to piped water is categorized into quartiles.

Analysis

We begin with descriptive analysis that looks at the distribution of child health outcomes in Phnom Penh. Next, we model these outcomes by year, migration status and wealth, adjusting for other characteristics. Our data are hierarchical wherein children are nested within households within villages. The health outcomes of children living in the same household are likely to be closely related as they share many characteristics. We also expect there to be a high degree of homogeneity in health outcomes of children within villages, in part due to unmeasured factors like shared access to health resources and shared knowledge of child care practices. At the same time, certain villages may be more likely to contain migrants or those with low wealth, and villages have varied access to health facilities and city resources such as piped water. An appropriate way of accounting for between village heterogeneity is to employ multilevel mixed effects models with random effects to account for village level variation (Raudenbush and Byrk 2002). Models were estimated using generalized linear latent and mixed models (GLLAMM) in STATA Version 13.1 (Rabe-Hosketh et al 2005). All models were specified hierarchical logit models.

Several random effects models are tested. The first is an intercept-only random effects model. For the analysis of underweight, a three-level model is used with the household as the second level, and village as the third level. For the vaccination analyses, a two-level model is used as there are only 14 households with more than one child in the analysis. The second model includes the main independent variables of wealth, migration status, and year of survey. This model allows us to determine whether migration and wealth impact on health outcomes and whether health has improved over time, other things being kept constant. In a third model, we add individual- and household-level covariates. In a fourth model, we add village-level covariates.

In a final model we tested for interaction effects between migration and wealth, and migration and survey year. The purpose of the interactions was to determine whether migration status impacted upon child health outcomes differently depending upon wealth quintiles and survey years. We found all interactions not to be significant; thus, no interaction effects are presented in the final models shown below.

Results

Sample characteristics

Individual and household level descriptive statistics are provided in Table 1. With respect to health outcome measures, 85.9% of children under two in 2004 and 86.3% of children under two in 2009 received BCG vaccine. There was no significant increase in BCG coverage among children ages two to 23 months residing in Phnom Penh from 2004 to 2009. Completion of the three-dose DPT vaccine decreased from 2004 to 2009, though the decline is not statistically significant. In 2004, 67.9% of children ages six to 23 months completed DPT vaccine; in 2009, 62.6% of children completed the vaccine. The proportion of children under age five who were underweight decreased significantly over the five year period from 2004 to 2009 ($p=.05$), decreasing from 35.9% in 2004 to 29.5% in 2009.

The proportion of children living in migrant households increased between 2004 and 2009. For those under five, the increase is statistically significant ($p=.000$). Specifically, in 2004, 36.4% of children under five lived in a migrant household. This increased to 50.6% by 2009. The percent of children under 2 categorized as being in a migrant household also increased between 2004 and 2009, but the change is not statistically significant, partly a function of relatively small sample size.

31.9% of households with a child under five were in the lowest wealth quintile, and 31.7% of households with a child under two were in the lowest wealth quintile. In 2009, 30.4% of households with a child under five were in the lowest wealth quintile, and 27.1% of households with a child under two were in the lowest wealth quintile. There was no significant change in the proportion of households with a child under five or under two in the lowest wealth quintile. It is worth noting that quintiles are evenly distributed across all Phnom Penh households, but this is clearly not the case when it comes to households with small children. It appears from these results that households with young children are more likely to fall into the poorer wealth categories than are the total of Phnom Penh households.

Other characteristics tend to show changes between 2004 and 2009, many of which are statistically significant. For instance, there was a decrease in household size, an increase in the percent of households that always treat drinking water, a decrease in the percent of mothers working outside the home, an increase in mother's educational level and an increase in father's educational level.

Bivariate relationships with child health outcomes

Table 2 shows bivariate relationships of household wealth and migration status with vaccination status and underweight across years. Interestingly, we see no significant bivariate difference between children in migrant and non-migrant households for BCG or DPT vaccination, or underweight status. Children in migrant households are slightly more likely to have received both BCG and DPT vaccinations in each survey year, but the difference is not significant. In 2004, children in migrant households were slightly more likely to be underweight than other children, though in 2009, they were slightly less likely to be underweight compared to non-migrant children. Again, these differences are not significant. In contrast, wealth does make a difference. In 2004, children in the lowest wealth quintile were significantly more likely to be underweight than children in higher wealth quintiles, and significantly less likely to have completed BCG and DPT vaccination. Specifically, while 48.1% of children in the lowest wealth quintile were underweight in 2004, the same was true of only 30.2% of children in other quintiles. In 2004, only 73.3% and 51.5% of children in the lowest wealth quintile received BCG and DPT vaccination respectively, compared to 92.0% and 75.3% of their counterparts in other wealth quintiles.

In order to determine whether migrant status and wealth quintile together make a difference in child health outcomes, we show the percentages for migrants in the lowest wealth quintile, and measures of significance test these percentages versus non-migrants and/or non-lowest wealth quintile. Children in migrant households in the lowest wealth quintile in 2004 were significantly less likely to receive BCG vaccine or complete DPT vaccine. These differences were no longer statistically significant in 2009. Migrant children in the lowest wealth quintile were significantly less likely to be underweight in 2009 compared to 2004; however, they were significantly more likely to be underweight than migrant children in households in higher wealth quintiles and non-migrant children in 2009.

Vaccination

Results of multilevel regression models for BCG vaccination status are shown in Table 3. The only statistically significant predictor is household wealth in models not adjusted for village level controls. As children move up wealth quintiles, the odds of receiving BCG vaccine increase. In Model 2, prior to the addition of control variables, for each increase in wealth quintile, a child’s log odds of receiving BCG vaccination increase by 0.43 (p=.01). After adding individual and household controls in Model 3, the log odds decline to 0.31, but are still of borderline significance (p<.10). However, after adding village controls in Model 4, household wealth is no longer significantly associated with BCG vaccination. Exponentiation of the log odds provides odds ratios. For Model 3, a child has 1.36 times the odds of BCG vaccination for each increase in wealth quintile. Also, village level variation is shown. While this variation is substantial, the standard errors are large, indicating between village heterogeneity may not be a factor in determining BCG vaccination; furthermore, village level covariates are not significantly associated with BCG vaccination.

DPT vaccination regression results are shown in Table 4. Again, the model does not present much statistical significance. Mother's age is a significant and positive predictor of completing the three-dose DPT vaccine series, with higher age indicating greater likelihood of vaccination. In the final multilevel model, each additional year of a child's mother's age increases the log odds of completing the DPT series by 0.10 (p=.02). Village-level variance in the final multilevel model is 3.02 with a standard error of 1.92, again suggesting that between village heterogeneity may not be a factor in predicting DPT vaccine completion. Village level controls are not significantly associated with completion of DPT vaccine.

While many of the coefficients are insignificant, especially among those of central interest to this analysis, they are nonetheless of fairly large magnitudes. Lack of significance is therefore likely to be a function of variance and small sample size rather than magnitude of the association. Therefore, it is worth noting that children classified as migrants are more likely than others to have received BCG and DPT vaccines. Indeed, exponentiation of the log odds ratio in Table 3 indicate that being in a migrant household increases the odds of BCG vaccination by a factor of 1.81, and increases the odds of DPT series by a factor of 1.59. These are substantial odds ratios. Year of survey is also not significant, although the direction of the relationship suggests a decrease in the tendency to receive vaccines in 2009 versus 2004, controlling for other factors.

Malnutrition

Multilevel regression results for underweight status are shown in Table 5. Because underweight status is measured for children under five, rather than the previous two outcomes, which are measured for those under two, the number of observations is greater and coefficients with similar magnitudes are now statistically significant. In Model 2, wealth quintile is associated with a lower probability of being underweight. In Models 3 and 4, wealth quintile is statistically significant and year of survey is of borderline significance, although migrant status is not a significant predictor of vaccination.

Among control variables, being a female child, mother's education, and mother's work outside the home are significantly associated with a child being underweight. Female children are significantly less likely to be underweight than male children; in the final model, girls have -0.40 log odds of being underweight compared to boys (p=.04). Children who have a mother with higher education attainment or a mother who works outside the home are significantly less likely to be underweight. Exponentiating the log odds in the final model, if a child's mother completes more than primary education, he or she has 0.60 times the odds of being underweight (p=.02) compared to children whose mother has a primary education or less. If a child's mother works outside the home, he or she has 0.56 times the odds of being underweight (p=.007). At the village level, distance to a health facility and the percent of households with piped water are not significantly associated with underweight status. Finally, a fair degree of household level and village level variance is present, but standard errors suggest that this variation is not statistically significant.

Interaction terms between year and migration status were not significantly associated with either BCG vaccination or DPT vaccine series completion, or with underweight. Therefore, they are omitted from Tables 3, 4, and 5. An interaction term between migrant status and wealth quintile was also not significant in any model, suggesting that the log odds of vaccination or being underweight among migrant children does not vary significantly by wealth quintile compared to non-migrant children. That interaction terms including year of survey were not significant suggests that children in migrant households were not significantly worse off in 2009 compared to these groups in 2004.

Discussion

In this study, we examined the associations of migration and household wealth status on key child health indicators in a context of rapid urbanization and migration in Phnom Penh, Cambodia. We also examined whether, adjusting for these and other characteristics, child health indicators changed over time. We used the Cambodian Socioeconomic Survey from 2004 and 2009, a nationally representative dataset that monitors a range of social, economic, health and demographic information about Cambodians and Cambodian households. Data in this analysis were limited to households in Phnom Penh. The childhood health indicators examined are important markers of access to care and child growth and development among young children. The main findings in this paper are that household wealth and maternal characteristics are significant predictors of key child health outcomes. Children in households in low wealth quintiles are significantly disadvantaged in accessing key preventive child health services, such as vaccination. These findings highlight the vulnerabilities faced by poor children living in urban Cambodia.

The analysis showed a profound increase in the proportion of children under five living in migrant households in Phnom Penh from 2004 to 2009, consistent with the rapid rural-urban migration occurring in Cambodia. However, migration status turned out to not be a significant predictor of vaccination or malnutrition. While the results are not statistically significant, a small number of observations, particularly with respect to vaccination status, accounts for a relatively large standard error. Therefore, we suspect that this analysis may be hampered by Type II statistical errors. Still, fairly substantial coefficients warrant noting of the direction of the relationship. In the vaccination analyses, migration is positively associated with vaccination; that is, migrants have a higher likelihood of being vaccinated. Other research shows that many migrants report receiving social support from others from their village of origin upon arrival in Phnom Penh, and many migrant women are well networked in Phnom Penh (Ministry of Planning 2012). Migrant women utilize a range of coping mechanisms to respond to child health needs, and may exhibit both vulnerability and resiliency in seeking care and overcoming barriers to services (Gagnon et al 2013). Social networks and support may mediate the negative effects of poverty on early childhood health outcomes by improving women's ability to attend health facilities to seek care for their children. Interaction terms including migration are not significant in models for either vaccination status or underweight. Therefore, the impact of household wealth quintile is statistically consistent across migrant status and year for these health outcomes.

Wealth quintile is a significant predictor of child health outcomes in urban Cambodia, and its effects on underweight status and vaccination is substantial. Our bivariate analysis shows that children in the lowest wealth quintile face significant disadvantages in accessing vaccination, as the poor are less likely to receive BCG vaccine. However, this relationship was no longer significant when controlling for household and village effects. Disparities in BCG vaccination may reflect lower access to facility-based delivery or, for those who deliver outside a health facility, access to a facility in the post-partum period. Place of delivery information is not available for all children in the CSES. Therefore, we were unable to assess whether delivery site is significantly associated with BCG vaccination in Cambodia, as it has shown to be in other countries (Mutua et al 2011; Hemat et al 2009). Maternal access to antenatal and obstetric care may be an important predictor of vaccination for Cambodian children. Cambodia has instituted a program for the poorest poor to receive free health services, though some who qualify are unaware of the program (Soeung et al 2012). Increasing awareness of this program may result in increased vaccination, and potentially increase coverage for post-natal care, post-partum family planning, and child health care services as low-income mothers more frequently interact with the health care system around birth and in the neonatal and infant periods. In bivariate analyses, poverty is also a significant predictor of completing the three dose DPT vaccine series, again highlighting the important role that household wealth plays in accessing child health services in urban Cambodia: the poorest poor children are especially at risk of not completing the recommended basic immunization package. These findings are consistent with other literature globally that finds a strong association between low socio-economic status and poor health outcomes in infancy and early childhood (Newachek et al 1996; Smith et al 2004; Brockerhoff and Hewett 2000; Amin et al 2010).

Generally, there appears to some improvement in health disparities among young children in Phnom Penh from 2004 to 2009, especially among poorer households. Bivariate results indicate that from 2004 to 2009, significant disparities among children in the lowest wealth quintile in underweight, and BCG and DPT vaccination, disappeared. BCG coverage among children in households in the lowest wealth quintile increased significantly in this time period.

The poor and migrants were not significantly less likely to complete DPT vaccine in 2009 compared to 2004, nor were migrants significantly less likely to receive BCG vaccine in 2009. However, bivariate analyses suggest lower overall coverage of vaccination in 2009 than in 2004. This may be due to the way that vaccination information was collected in the CSES, described below. Significantly fewer households in 2009 presented a vaccine card than households in 2004, likely accounting for this finding. Regression analyses, controlling for other factors, suggest children were significantly less likely to be underweight in 2009 compared to 2004.

Maternal characteristics are an important predictor of children's health status in an urban Cambodian population. Maternal age is a significant predictor of DPT vaccination completion, and maternal education and working outside the home are significantly and negatively associated with underweight. Children with older mothers have greater odds of completing DPT vaccination, consistent with findings from other countries (Salmon et al 2009; Babalola 2008). In the present study, children of women who have completed more than primary school are less likely to be underweight; other findings have shown that women with more years of formal education and those who report higher autonomy are less likely to have stunted children (Shroff et al 2009; Bomela 2009). Previous studies have reported mixed findings on the effect of maternal work outside the home on child health outcomes (Ulijaszek & Leighton 1998; Lamontagne et al 1998); the present study found that children whose mothers work outside the home are less likely to be underweight. These women may be more able to buy more nutritious foods for their children as a result of their income, or have stronger social networks as a result of their employment through which they receive information about child diet and nutrition. Maternal education and having a mother who worked were not significantly associated with BCG or DPT vaccination in this analysis, nor was paternal education shown to significantly predict vaccination or underweight in the urban Cambodian context. However, the direction of these relationships in the current analysis, that parental education is positively associated with increased likelihood of vaccination, is consistent with findings from other countries. Similarly, though not statistically significant, children with older mothers have a lower likelihood of being underweight. Interestingly, we found that higher paternal education was positively associated with being underweight; however, this finding may be due to missing data, described below. Girl children in urban Cambodia enjoy a protective factor against underweight compared to their male counterparts. Cambodia is not a country that has been shown to exhibit son preference, and other countries that do not exhibit son preference have also found girls less likely to be malnourished than boys in an urban area (Dapi et al 2009).

There was no significant between-neighborhood variance for either vaccination or underweight status, nor significant household variance for underweight status. Villages in this survey are an administratively defined area, and may not reflect true, lived neighborhood boundaries. For example, residents of a village may choose to access different health centers depending on the location of their residence within a village; therefore, the village-level measure of distance to a health center may not accurately represent the true distance to a health center for all residents of a village. Moreover, social networks may not be reflected by village boundaries; workplace and village of origin are important determinants of women's social networks, and the impact of these networks may be more important than village networks.

The CSES provides detailed wealth information, which more adequately captures a household's socio-economic status in comparison to other surveys such as the DHS; it also provides detailed child health outcome and migration information. A main limitation of the present study is the small sample size, especially for the vaccination analyses. Sampling in the CSES is based on census area tracts. Informal squatter areas are at times omitted from the formally defined census area, which may be a limitation that influences the effects of migration in this analysis.

The CSES measures vaccination differently than other household surveys such as the Demographic and Health Survey (DHS). Using only the vaccine card for vaccination outcomes likely underrepresents true vaccination rates; unlike the DHS, the CSES does not rely on mother's recall, which provides greater reliability to the CSES measure. Thus, it is difficult to compare the coverage estimates from these two surveys (Suarez et al 1997). While the anthropometric measure of underweight can reflect both acute and chronic malnutrition, the current analysis does not capture other key measures of malnourishment, stunting and wasting, because these measures were not reliably collected in the 2009 CSES. Another challenge with the current data is that 3.1% of children are missing maternal data and were excluded from the analysis; 9.6% are missing information on paternal educational attainment.

This analysis shows the special disadvantage that the poorest children face in child growth and development. The poorest poor in urban Cambodia face significant barriers to completing basic vaccinations after birth and in the first year of life, and are significantly more likely to be malnourished. Future analyses should examine rural sending households to better understand the impact of migration on children, as well as urban-rural dichotomies in key child health outcomes. Analysis of factors of vulnerability and resiliency in child health care seeking among migrant women in Cambodia will provide further clarity on the experience of migrant children in Phnom Penh. Examining stunting and wasting among migrants and the urban poor can further elucidate how migration and poverty impact child malnutrition and growth and development in Cambodia. Expanding an analysis of vaccination coverage, and understanding care seeking behaviors for fever and severe cough in urban Cambodia can help distill how socially disadvantaged households access care for young children. It is also important to how migration impacts young children differentially, including children left behind in rural areas, and children who are moved from their village versus those who are born to migrant parents in Phnom Penh. Public health programmers and policy makers in urban Cambodia should continue to target and promote improved health care access towards the poorest poor, and seek to reach migrant households among the lowest wealth quintile.

It is somewhat disappointing, given the magnitude of the associations, that migrant status was not a significant determinant of vaccination outcomes. Suspecting a Type II error, our next set of analyses will expand to other urban areas of the country and, indeed, begin to examine child health outcomes across Cambodia. The consistent direction and substantial magnitudes of migrant status with vaccination and underweight status in the current study suggests migrant children in Phnom Penh may enjoy a protective factor against poor health outcomes, perhaps due to social networks and support among migrant women. With rapid urbanization and an increasing proportion of young children living in migrant households in urban Cambodia, this important topic merits further study to distill these relationships. As poverty is significantly associated with key child health outcomes in urban Cambodia, special attention should be paid to migrant households in the lowest wealth quintile, especially those living in informal squatter settlements.

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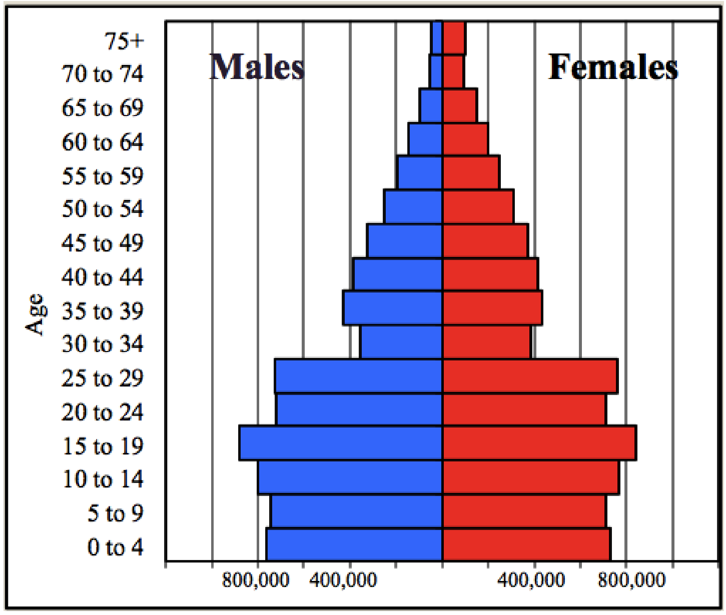

Figure 1. Population pyramid for Cambodia, 2010.

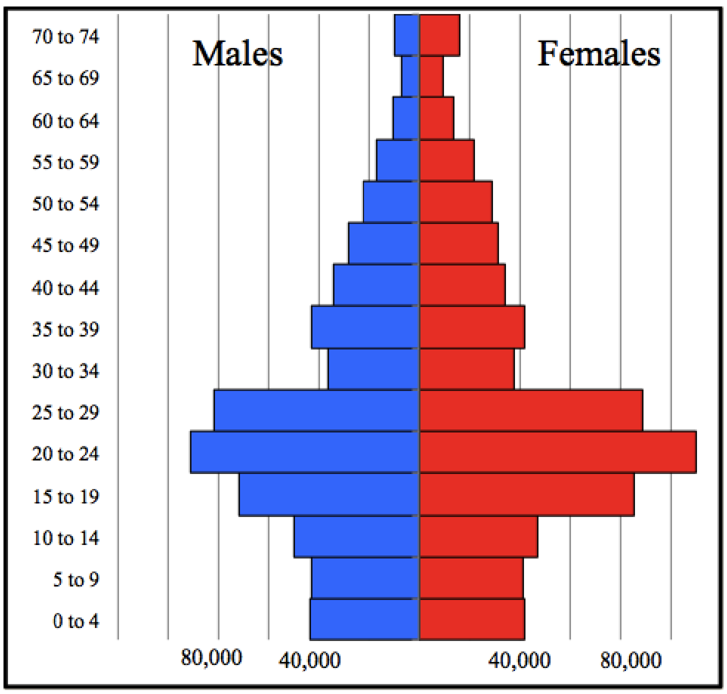

Figure 2. Population pyramid for Phnom Penh, 2008.

Table 1. Household, child, and parent characteristics by year.

	Under 5		Under 2	
	2004 (N=434)	2009* (N=429)	2004 (N=170)	2009* (N=185)
Selected child health outcomes				
Receipt of BCG vaccination**	-	-	85.9%	86.3%
Completion of 3 dose DPT vaccination series***	-	-	67.9%	62.6%
Percent underweight	35.9%	29.5%*	-	-
Percent migrant households	36.4%	50.6%*	45.9%	54.0%
Wealth quintile				
Poorest	31.9%	30.4%	31.7%	27.1%
Poorer	24.2%	23.4%	25.5%	24.6%
Middle	21.5%	19.9%	14.3%	22.9%
Richer	12.8%	15.7%	11.7%	14.5%
Richest	9.5%	10.6%	16.8%	10.9%
Child sex				
Male	50.8%	55.1%	49.9%	51.1%
Female	49.2%	44.9%	50.1%	48.9%
Child age				
Less than one year	22.1%	22.9%	56.2%	51.3%
One	17.2%	21.7%	43.8%	48.7%
Two	16.1%	18.0%	-	-
Three	23.2%	19.6%	-	-
Four	21.4%	17.8%	-	-
Mean household size	6.17	6.16*	6.36	6.09
Percent households that always treat drinking water	86.2%	91.0%*	85.9%	91.7%
Mother characteristics				
Mean age (years)	29.7	29.2*	28.2	27.8
Percent working outside the home	56.5%	51.5%	54.2%	47.6%
Education				
Incomplete primary	31.3%	21.5%*	36.4%	18.3%*
Complete primary	12.7%	7.7%*	14.3%	7.0%*
Incomplete secondary	34.3%	38.9%*	32.4%	42.3%*
Complete secondary	6.2%	11.8%*	4.4%	12.2%*
Post-secondary	15.6%	20.2%*	12.5%	20.3%*
Father characteristics				
Mean age (years)	33.8	33.6*	32.4	32.3
Education				
Incomplete primary	15.3%	12.4%*	17.0%	10.4%
Complete primary	9.4%	4.2%*	7.2%	5.3%
Incomplete secondary	35.3%	33.5%*	39.8%	35.2%
Complete secondary	12.3%	19.1%*	12.7%	20.6%
Post-secondary	27.7%	30.8%*	23.3%	28.4%

*Indicates a statistically significant difference comparing 2004 and 2009 (p<.05)
**Among children 2 to 23 months of age at time of survey
***Among children 6 to 23 months of age at time of survey

Table 2. Bivariate associations with migrant status and household wealth by year.

	2004	2009
% underweight (N=863)	35.7%	29.4%
Migrant	36.1%	28.2%
Non-migrant	35.5%	30.6%
Lowest wealth quintile*	48.1%§	35.7%
Other wealth quintiles	30.2%	26.7%
Migrant x Lowest wealth quintile*	47.2%	42.0%+
% received BCG vaccination (N=312)	86.2%	85.6%
Migrant	89.6%	88.9%
Non-migrant	83.3%	81.8%
Lowest wealth quintile*	73.3%§	78.7%
Other wealth quintiles	92.0%	88.3%
Migrant x Lowest wealth quintile	64.3%+	85.0%
% completed DPT vaccination (N=232)	68.2%	60.6%
Migrant	70.8%	62.1%
Non-migrant	66.1%	58.9%
Lowest wealth quintile	51.5%§	51.5%
Other wealth quintiles	75.3%	64.0%
Migrant x Lowest wealth quintile	36.4%+	58.3%

*Indicates a statistically significant difference comparing 2004 and 2009 (p<.05)
§Indicates significantly more likely to experience outcome than children in other wealth quintiles in the survey year (p<.05)
+Indicates significantly more likely to experience outcome than non-migrant children in other wealth quintiles in the survey year (p<.05)

Table 3. Mixed-effects logistic regression for completion of BCG vaccines (N=312).

	Model 1		Model 2		Model 3		Model 4	
	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Year of survey 2009			-0.14	(0.27)	-0.24	(0.27)	-0.18	(0.27)
Wealth quintile			0.43*	(0.17)	0.31+	(0.18)	0.30	(0.18)
Migrant household			0.56	(0.45)	0.62	(0.46)	0.59	(0.45)
Child is female					-0.46	(0.43)	-0.46	(0.42)
Mother's age					0.02	(0.04)	0.02	(0.04)
Mother's education					0.35	(0.47)	0.37	(0.47)
Mother works outside the home					0.14	(0.44)	0.07	(0.44)
Father's education					0.48	(0.49)	0.55	(0.49)
Village distance to a health facility							-0.05	(0.07)
Percent of households in village with piped water							-0.17	(0.28)
Village-level variance	2.89	(1.52)	2.62	(1.40)	2.33	(1.31)	2.08	(1.24)
Constant	2.67		4.26		3.47		1.93	
Log likelihood	-119.40		-114.72		-112.42		-111.78	

**p<.01,*p<.05, +p<.10

Table 4. Mixed-effects logistic regression for completion of DPT vaccines (N=232).

	Model 1		Model 2		Model 3		Model 4	
	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Year of survey 2009			-0.28	(0.24)	-0.36	(0.28)	-0.31	(0.27)
Wealth quintile			0.25+	(0.15)	0.22	(0.18)	0.25	(0.18)
Migrant household			0.05	(0.40)	0.42	(0.45)	0.46	(0.45)
Child is female					0.61	(0.42)	0.53	(0.42)
Mother's age					0.09*	(0.04)	0.10*	(0.04)
Mother's education					0.21	(0.45)	0.28	(0.45)
Mother works outside the home					0.15	(0.44)	0.13	(0.45)
Father's education					0.11	(0.48)	017	(0.48)
Village distance to a health facility							-0.05	(0.07)
Percent of households in village with piped water							-0.44	(0.30)
Village-level variance	2.60	(1.52)	2.64	(1.51)	3.40	(2.04)	3.02	(1.92)
Constant	0.91		0.55		-3.26		-1.68	
Log likelihood	-145.87		-143.58		-137.79		-134.51	

**p<.01,*p<.05, +p<.10

Table 5. Mixed-effects logistic regression for underweight status (N=863).

	Model 1		Model 2		Model 3		Model 4	
	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Year of survey 2009			-0.36	(0.24)	-0.21+	(0.12)	-0.23+	(0.12)
Wealth quintile			-0.26**	(0.08)	-0.18*	(0.09)	-0.19*	(0.09)
Migrant household			0.10	(0.20)	0.09	(0.22)	0.08	(0.22)
Child's age					0.08	(0.07)	0.06	(0.06)
Child is female					-0.41*	(0.20)	-0.40*	(0.20)
Mother's age					-0.03	(0.02)	-0.03	(0.02)
Mother's education					-0.53*	(0.23)	-0.51*	(0.23)
Mother works outside the home					-0.60**	(0.22)	-0.58**	(0.22)
Father's education					0.06	(0.24)	0.06	(0.23)
Household size					0.02	(0.05)	0.01	(0.05)
Household treats drinking water					0.25	(0.35)	0.19	(0.35)
Village distance to a health facility							0.04	(0.03)
Percent of households in village with piped water							0.11	(0.13)
Household-level variance	0.99	(0.68)	0.93	(0.66)	1.06	(0.70)	1.20	(0.76)
Village-level variance	0.79	(0.32)	0.69	(0.30)	0.60	(0.31)	0.54	(0.31)
Constant	-1.07		0.79		1.16		0.94	
Log likelihood	-530.78		-523.56		-497.81		-495.06	

**p<.01,*p<.05, +p<.10